REMARKS

Claims 21 and 22 are rejected under 35 U.S.C. 112, second paragraph as being indefinite. Specifically, Claims 21 and 22 are objected to on the ground that they depend from cancelled Claim 2. Claims 21 and 22 have been amended to depend from Claim 1 instead. All the claims are therefore believed to be in compliance with 35 U.S.C. 112.

Claims 1, 3, 4, 6-29, 31-45 and 83-85 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 4,740,079 to Koizumi et al. in view of U.S. Patent 4,449,818 to Yamaguchi et al. Many of the rejected claims have been amended, and the rejection is traversed in so far as they are applied to the claims as amended.

Claim 1 has been amended to require that the second wavelength of the second radiation beam be greater than the ultraviolet or deep ultraviolet wavelength of the first beam, so that radiation from the second beam penetrates the surface of the substrate by a distance greater than that by the radiation from the first beam. Claim 1 has also been amended to add the limitation that first data set or sets are generated from the detection outputs containing only data on anomalies at or substantially at the surface of the substrates and second data set or sets containing data on anomalies away from the substrate surface. In this manner, anomalies at or substantially at the surface of the substrate can be detected independently from anomalies away from the substrate surface from the data sets.

The above-described features have important commercial and practical applications. Since radiation in the ultraviolet spectrum is attenuated severely by substances such as silicon, the anomalies detected using the first radiation beam is confined to the top surface of a sample, such as a semi-conductor wafer or the top surface

plus a very shallow region underneath the top surface, typically of the order of tens of nanometers. The anomalies detected by means of the first radiation beam is therefore confined to this region. The wavelength contained in the second radiation beam, on the other hand, is greater than the ultraviolet wavelength of the first radiation beam so that the radiation at the second wavelength penetrates the surface of the substrate into regions beyond the shallow region inspected by the ultraviolet wavelength of the first radiation beam. In this manner, anomalies at the top surface of the substrate and within the shallow region immediately underneath the top surface can be detected substantially separately and independently from anomalies present at a greater depth from the top surface of the substrate than the shallow region.

There is increasing demand for better performance of electronic devices. Thus, it is desirable to be able to provide transistors that can be turned on at a faster speed. One of the technologies that has come on stream for improved transistor speed is silicon-on-insulator technology. Enclosed is an article entitled "Silicon-on-Insulator Technology" from SysOpt.com with a review date of November 8, 2000 that provides an explanation of such technology. As can be seen from the article attached, the silicon-on-insulator technology relies on a semiconductor structure where a thin layer of silicon is placed on top of an insulating layer such as silicon oxide to reduce the capacitance of the transistor, which in turn increases the speed of the transistor. This means that anomalies may appear at the top surface of the thin silicon layer as well as at the interface between the silicon layer and the oxide layer at a small distance from the silicon layer top surface. It would therefore be important to be able to distinguish between anomalies at the top surface of the thin silicon layer from anomalies at the interface between the thin silicon

layer and the oxide layer. The above-described features of Claim 1 permits anomalies at the top surface of the silicon layer to be detected in a manner which is largely unaffected by anomalies present at the interface between the silicon layer and the oxide layer. This is the case because radiation in the first beam in the ultraviolet spectrum is attenuated severely by the thin silicon layer and does not reach the interface between the silicon layer and the oxide layer, despite the fact that the interface is at a small distance from the top surface. In this manner, the detection of top surface anomalies of the silicon layer is unaffected by anomalies that may be present at the interface. The method of Claim 1 therefore provides important advantages to the semiconductor manufacturer, who would then be able to distinguish between anomalies at the top surface of the silicon layer from anomalies at the interface. Silicon-on-insulator wafers are mentioned in paragraph 51 of the present application.

It is believed that neither Koizumi nor Yamaguchi teaches or suggests the above-described features of Claim 1. If anything, Koizumi appears to teach away from the above-described features of Claim 1. According to Koizumi, the problem in detecting foreign substances on a wafer with a pattern thereon is that the scatter from the edges of the pattern may be confused with the scatter from small foreign particles, since they would be of the same or comparable intensities, so that the threshold for detection must be set higher to avoid false positives. In this manner, only large foreign particles are detectable. See Koizumi, column 3, lines 41-55 and Figs. 49(a)-(c). The solution proposed by Koizumi is outlined in column 9, lines 1-26 referring to Figures 17 and 18. S-polarized low angle illumination beam 15L at wavelength λ_1 and high angle S-polarized illumination beam 15H (wavelength λ_2) are applied to the same point on the

specimen and only P components are detected and compared by detector arrays 20H and 20L. The result can be observed from Figure 18b, when the sample is illuminated by the low angle beam 15L, the polysilicon silicon pattern 2, small particle 3a and large particle 3b scatter at respective intensities shown in Figure 18b. As can also be observed from Figures 18d and 18e, when illuminated by a high angle beam 15H, pattern 2 will scatter at a high intensity whereas particles 3a, 3b would scatter at a comparatively lower intensity as shown in Figure 18e. Therefore if the scatter intensities in Figure 18b are used alone for detection of particles, in order to screen out a false positive that would be caused by the scattering from pattern 2, the threshold would have to be set high enough so that only the scatter from large particle 3d would be detectable as shown in Figure 18c. As a solution, Koizumi proposes to obtain the ratio between the scattered intensities (V_L) measured by using a low angle beam 15L and the scattered intensities (V_H) observed when the same pattern and particles are illuminated by means of a high angle incident beam 15H. This means taking the ratio between the scattered intensities shown in Figures 18b and the corresponding intensities shown in Figure 18e, and the result is shown in Figure 18f. If m is set as the threshold, this will effectively eliminate the scattering from pattern 2 as a false positive and enable the detection of both the small particle 3a as well as the large particle 3b as shown in Figure 18g.

From the above, it is evident that the solution proposed by Koizumi requires a computation of the ratio between the radiation detected when a sample is illuminated by a low angle incidence beam and the intensity detected when the sample is illuminated by a high angle incidence illumination beam.

Koizumi fails to teach or suggest the above-described features of Claim 1. Koizumi fails to teach or suggest the use of ultraviolet or deep ultraviolet wavelengths so as to detect only anomalies at or near the surface of the substrate and the use of a longer wavelength for detecting anomalies that may be present at depths beyond that detected by the ultraviolet wavelength. Koizumi also fails to teach or suggest the generation of two different data sets, one containing only data on anomalies at or near the surface of the substrate and the second one containing data on anomalies away from the surface of the substrate, so that anomalies at or near the surface of the substrate are detectable independently from anomalies away from the surface of the substrate.

As noted in the previous amendment submitted on February 27, 2003, Koizumi employs two different wavelengths in order to enable the detection results using high angle illumination to be distinguished from the detection results using low angle illumination. There is no inherent reason why Koizumi would want to use ultraviolet or deep ultraviolet radiation just to distinguish between the illumination at high and low angles of incidence. Furthermore, Koizumi's scheme relies on the fact that both the low angle and high angle illumination beams be directed to and inspect the same anomalies, as illustrated in Figures 18a and 18d. Otherwise, V_L would represent scattering from anomalies that are different from the anomalies that give rise to V_H, so that the ratio between V_L and V_H is meaningless, and Koizumi's method would fail. In claim 1, however, the two illumination beams are used for the detection of different anomalies: anomalies at or near the top substrate surface and those away from the surface.

Furthermore, Koizumi's proposed solution for detecting small particles requires computing the ratio of the detected scattering from the low angle incidence beam to the

detected scattering from the high angle incidence beam. In contrast, in the method of Claim 1, the anomalies interrogated by the ultraviolet wavelength are identified independently from the anomalies identified by means of the radiation of the longer wavelength.

From the above, it is clear that Koizumi appears to teach away from the above-described features of Claim 1. In view of the above differences, it is believed that there is no reason or motivation to modify Koizumi so as to arrive at the limitations of Claim 1. Yamaguchi also fails to remedy the above-described deficiencies of Koizumi so that a combination of Koizumi and Yamaguchi, even assuming arguendo that it would have been obvious to do so, also fails to teach or suggest amended Claim 1. Claim 1 is therefore believed to be allowable.

Claims 3 and 4 are believed to be allowable since they depend from allowable Claim 1. They are further believed to be allowable on the ground of limitations added in these claims. Thus Claim 3 adds the limitation of documenting the presence of an anomaly if the detected radiation shows that the first radiation beam was scattered upon interacting with the top surface. Figure 18 of Koizumi, contrary to the opinion of the Examiner, does not teach or suggest such a limitation. As described above, Figure 18 merely illustrates the various scattering intensities from pattern and from large and small particles and documents the presence of an anomaly only when the ratio V_L to V_H exceeds a certain threshold m. In Claim 3, in contrast, the presence of an anomaly is documented if the detected radiation shows that the first radiation beam containing the ultraviolet or deep ultraviolet wavelength was scattered upon interacting with the top surface, without requiring the computation of the ratio V_L/V_H. By the same rationale, the

limitation contained in Claim 4 is also not taught or suggested by Koizumi, contrary to the opinion of the Examiner.

The Examiner's indication that Claims 5, 49 and 70 would be allowable if it were written in independent form is noted with appreciation. This has not been done since the claims upon which these claims depend are also believed to be allowable.

Claims 6-9 and 11-13 are believed to be allowable since they depend from allowable Claim 1; they are also believed to be allowable on the ground of the specific limitations in these claims. As noted above, the only reason for Koizumi to use different wavelengths for the high and low angle incident beams is to be able to distinguish between the scattered radiation from the two beams. We believe that there is no reason or motivation for Koizumi to adopt the specific wavelengths in Claims 6-9. The examiner has failed to address the limitations in claims 6-9 and 11-13. As for Claims 11-13, it would be undesirable for Koizumi to employ the two wavelengths in these claims because the scattering resulting from the two wavelengths would be from different anomalies. As noted above, this would render Koizumi's solution as outlined in Figure 18 impossible. Therefore Koizumi appears to teach away from the limitations of Claims 11-13. Claims 14-20 are believed to be allowable since they depend from allowable Claim 1. Claims 21 and 22 are believed to be allowable for the same reasons as those outlined above for Claims 3 and 4.

For substantially the same reasons as those explained above for claim 1, Claims 23 and 24 are also believed to be allowable over Koizumi and Yamaguchi. Claims 25-27 are believed to be allowable since they depend from allowable Claim 24. Claims 28, 29, 31-34 are believed to be allowable for substantially the same reasons as those explained

above for Claims 6-9 and on the ground that they depend from allowable Claim 24. Claims 33-35 are believed to be allowable since they depend from allowable Claim 24 and for substantially the same reasons as those explained above for Claims 11-13. Claims 36-40 are believed to be allowable since they depend from allowable claims. Claim 41 is believed to be allowable since it depends from allowable Claim 1 and on the strength of the limitation in this claim. The Examiner is of the opinion that "it would have been obvious to use the basic device of Koizumi et al. for the purpose of detecting defects on the top and within the substrate because the device would function in the same manner." We respectfully disagree. As noted above, in order for Koizumi's solution to function, the high angle incidence beam and the low angle incidence beam should interrogate the same defects, namely the defects above the surface of the substrate, rather than within the substrate. Koizumi is simply entirely silent as to how to detect or whether it is desirable to detect defects on the top and as well as within the substrate area, and the examiner has failed to demonstrate why the basic device of Koizumi et al. would function in the same manner for the purpose of detecting defects on the top and within the substrate. As noted above, Koizumi's device simply does not function when used for detecting defects on the top and within the substrate (i.e. detecting different anomalies), contrary to the opinion of the Examiner. In regard to Claim 45, column 18, lines 55-59 of Koizumi describes merely polysilicon and silicon dioxide patterns on a wafer specimen surface. Such wafer specimen has nothing to do with silicon-on-insulator wafers.

As for Claim 42, Koizumi and Yamaguchi simply fail to teach or suggest using two different radiation beams at different incidence angles, both containing ultraviolet wavelengths, for detecting anomalies only on the top surface of the substrate. Koizumi

and Yamaguchi also fail to teach or suggest the specific wavelengths of Claims 43 and 44. The examiner has failed to address the limitations in claims 42-44. For these reasons, Claims 42-44 are believed to be allowable over Koizumi and Yamaguchi. Claim 45 is also believed to be allowable since it depends from allowable Claim 42.

Claims 46-48, 50-69 and 71-82 are rejected under 35 U.S.C. 103(a) as being unpatentable over Koizumi in view of U.S. Patent 5,623,341 to Hunt and Yamaguchi. The rejection is respectfully traversed in so far as it is applied to the claims as amended.

A reference is non-analogous art if it is not within the field of endeavor of the invention of the rejected claim and not reasonably pertinent to the particular problem with which the inventors are involved. In re Deminski 230 U.S.P.Q. 313-315 (Fed. Cir. 1986). It is believed that Hunt is non-analogous art and should therefore be removed as a reference. Hunt relates to non-linear second order surface spectroscopy used to monitor the condition of a surface such as corrosion, contamination (such as an oil residue left after freon is evaporated) and deposition. Hunt's method is therefore outside the field of endeavor of the rejected claims which are for detecting anomalies of a surface such as particles or defects on or in the surface. Furthermore, the particular problem with which the inventors are involved was the detection of anomalies at or near the surface of a substrate separately from the detection of anomalies away from the surface where the anomalies are particles or defects in the surface or in the substrate. Invention of Claims 46, 47, 50-69 and 71-80 all concern the use of ultraviolet light for the purpose of inspecting defects at or near the top surface of the substrate, whereas Hunt chooses the frequency of the radiation used depending upon whether the media is transparent to such frequencies. See column 3, lines 45-49. Thus it is believed that Hunt is not reasonably

pertinent to the particular problem with which the inventors are involved. Hunt is therefore non-analogous art and should be removed as a reference.

Claims 46 and 67 have been amended to contain limitations similar to that of Claim 1 discussed above. Even assuming arguendo that Hunt may be considered together with Koizumi and Yamaguchi, Hunt nevertheless fails to remedy the deficiencies noted above in Koizumi and Yamaguchi with respect to claims 46 and 67. In particular, Hunt also fails to teach or suggest the use of two radiation beams, one containing ultraviolet radiation and the other radiation with the wavelength longer than the ultraviolet radiation of the first beam for interrogating anomalies at or near the surface of the substrate in the case of the ultraviolet wavelength and in a region away from the surface in the case of the longer wavelength. As will be apparent from Figures 4A and 4B of Hunt, Hunt relies on the interference of two frequencies f_1 and f_2 to produce the summed frequency $f_1 + f_2$ for its operation. In other words, Hunt's technique relies on interference between the two incident beams, so that the detection by means of one beam is not independent of detection by means of the other. Hunt therefore also teaches away from the limitation of Claims 46, and 67 where the anomalies at or substantially at the surface of the substrate are detected using an UV or deep UV wavelength in one beam independently from anomalies away from the surface of the substrate using a longer wavelength in a different beam.

From the above, it is believed that Claims 46 and 67 are believed to be allowable over the three cited references either individually or in combination. Claims 50 and 72 are believed to be allowable since they depend from allowable Claims 46 and 67 and for reasons similar to those explained above for Claims 6-9. Claim 51 is believed to be

allowable since it depends from Claim 46. Claims 52 and 72 are believed to be allowable since they depend from allowable Claims 46 and 67 and for reasons similar to those explained above for Claim 11 and 12. Claims 53 and 73 are believed to be allowable since they depend from allowable Claims 46 and 67 and for reasons similar to those explained above for Claim 13.

Claims 54-57 are believed to be allowable since they depend from allowable Claim 46. Claim 58 is believed to be allowable since it depends from allowable Claim 46 and for reasons similar to that of Claim 4 above. Claim 58 is believed to be allowable since it depends from allowable Claim 46 and for reasons similar to that of Claim 4 above. Claim 59 is believed to be allowable since it depends from allowable Claim 46 and on the ground of the limitation added in this claim. None of the references cited by the Examiner teaches or suggest such feature. For reasons similar to that explained above for Claim 41, Claim 60 is likewise believed to be allowable and also on the ground that Claim 60 depends from allowable Claim 46. Claim 62 is believed to be allowable on the ground that it depends from Claim 46 and for reasons similar to that above for Claim 3. Claims 61, 63, 64 are believed to be allowable since they depend from allowable Claim 46. Claim 65 is believed to be allowable since it depends from allowable Claim 46 and for reasons similar to that for claim 45. Claim 66 is believed to be allowable since it depends upon Claim 46.

Claims 68 and 71 are believed to be allowable since they depend from allowable claims as are Claims 74-77. Claim 66 is believed to be allowable since it depends upon Claim 46. Claims 72, 78 are believed to be allowable since they depend upon Claim 67 and on the ground of limitations in these claims which are not taught or suggested by any

art of record. Please refer to the arguments above for claims 6-9 in reference to claim 78, and for claims 11-12 in reference to claim 72.

The Examiner has failed to address the limitations in Claim 81 and it is believed that none of the three references cited by the Examiner teaches or suggests the features of Claim 81. Specifically, since the use of certain types of radiation such as ultraviolet radiation may damages a substrate with a low K dielectric material, two radiation beams with wavelengths in the visible range are used for detecting the anomalies of such substrate. Such features are not taught or suggested by any of the art of record. Since the Examiner has failed to present a prima facie case of obviousness, Claim 81 is therefore believed to be allowable. Claim 59 adds a similar limitation. Claims 82-85 are believed to be allowable since they depend upon Claim 81 and on the ground of the limitations added in these claims. Thus claim 83 adds a limitation similar to that of claim 45.

Claims 1, 3-5, 14-15, 20-22, 24, 26, and 36-38 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-51 of U.S. Patent No. 6,201,601. Claims 1, 3-5, 14-15, 20-22, 24-26, and 36-38 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 85-114 of copending Application No. 09/746,141. Claims 6-13, 16-19, 23, 25, 27-29, 31-35, and 39-45 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-51 of U.S. Patent No. 6, 201, 601. Claims 6-13, 16-19, 23, 27-29, 31-35, and 39-45 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 84-114 of copending Application No. 09/746,141. Attached is a Terminal Disclaimer referring to U.S. Patent

No. 6,201,601 and Application No. 09/746,141. The obviousness-type double patenting rejection is therefore believed to have been obviated.

Claims 1, 3-47, 49-68, 70-85 are presently pending in the application. Reconsideration of rejections is respectfully requested and an early indication of the allowability of all the claims is earnestly solicited.

EXPRESS MAIL NO.: EV321704785US February 22, 2005

Respectfully submitted,

2/22/05

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Date